Design of an Outcome-Based Education Assessment Plan for Student Outcomes: Basis for the Development of Assessment Tools

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Abstract - *Good output is the product of good transformation process. An assessment that is correctly planned and well executed helps in the overall development of the learning process of the learners and an important indicator of the quality of the product of the school. The knowledge acquired by the students could be measured with the use of different assessment techniques with the ability to measure the learning based on the real-world environments. This study aimed to develop an assessment process flowchart, formulate fair and measurable performance indicators anchored to student outcomes, determine the formative and summative courses to be assessed to satisfy the performance indicators, provide assessment methods, assessment targets and performance targets for the formulation of the improvements with expected higher degrees of attainment of the program educational objectives, and determine the cycle assessment. Internal desk research method was utilized to analyze and interpret the gathered information necessary for the study. Results showed that there were 12 steps to follow for effective assessment, each student outcomes were provided with at least 2 performance indicators, formative and summative courses were identified for the assessment, assessment and evaluation for formative and summative courses were developed to measure how well the students can utilize their learning on the real world scenario, and two-year-assessment cycle was developed to ensure continuous monitoring of the results to ensure quality.*

Keywords: Assessment, Performance Indicators, Students Outcomes, Formative and Summative Courses, Cycle Assessment.

INTRODUCTION

Change is inevitable. Generations of yesterday are different from today's generation; therefore, the manner of educating them should cope with present generation. According to Spady [1], "clearly focusing and organizing everything in an educational system around is essential for all students to be able to do successfully at the end of their learning experiences". Philippine Higher Educations are at the crossroads, faced with many new demands and challenges brought by the new typology set by Commission on Higher Education (CHED) and implementation of the Outcomes-based Education (OBE) [2]-[5]. Yet, in the Philippines, educators still prepare to apply content-based assessment instead of outcome-based assessment. They, perhaps, believe that content-based assessment, like examinations, is better than outcome-based assessment and traditional teaching is easier to implement.

Good output is the product of good transformation process – the input and the process. In a classroom scenario, the knowledge imparted by the teacher is the input, the method used in imparting the knowledge is the process, and the ability of the learner to apply the knowledge acquired is the output. On the other hand, the acquired knowledge is measurable by means of different assessment techniques that have the ability to measure the learning based on the real-world environments of the students. An assessment that is correctly planned and properly executed helps in the overall development of the learning process of the learners and an important indicator of the quality of the product of the school. Consequently, acquiring knowledge that cannot be used in the real world scenario is useless and a waste of time. Outcome-based assessment, as compared to content-based assessment, does not focus on individual learner, teacher or staff, but rather on students as a group.

To enforce the full implementation of OBE in the Philippines, Institutions of Higher Learning are required to offer engineering with full implementation of OBE system by the end of Academic Year 2016-2017 according to CMO No. 37, Series of 2012 [6].

OBE is a prerequisite for every professional program that enables the students to perform in a globally competitive environment [7]-[12]. Likewise, OBE implementation is not only a requirement of the Commission on Higher Education (CHED) but also of other accrediting body like Accreditation Board of Engineering and Technology (ABET). Any school that have passed the accreditation by signatory bodies of Washington Accord and other signatory bodies should recognize their graduates as having met all the requirements prescribed to the practice of engineering [6]. As Eide [13] inscribed that "Graduation from ABET-accredited institutions satisfies the degree requirements automatically". Hence, this study explored on the possibility of designing the assessment of student outcomes process flow that would be suitable for the engineering programs of the University under study.

To realize the requirements of CHED and ABET, this research provides a clear program on OBE assessment plan that could be used for effective implementation of OBE in the University under study.

OBJECTIVES

Philippine Technological Council (PTC) is the sole organization recognized by the Commission on Higher Education to accredit engineering program in the Philippines while ABET for International accreditation. To meet the requirements of PTC and/or ABET this study aimed to develop an assessment process flowchart; formulate measurable performance indicators anchored to student outcomes; determine the formative and summative courses to be assessed to satisfy the performance indicators; provide an assessment and evaluation matrix for formative and summative courses and determine the appropriate assessment for a particular program.

METHOD

Internal desk research method was utilized to analyze and interpret the gathered information from the practices and processes of the institution necessary for the study. The main advantage here in performing internal desk research is that it involves internal and existing organizational resources to organize the collected data in such a way that it is not only efficient but also usable [14].

There are four level of assessment: 1. Classroom assessment, 2. Course assessment, 3. Program assessment, and 4. Institutional assessment [15].This research concentrated on the course-level assessment which is a cyclic process of determining the learning objectives aligned with the curriculum, collecting evidence (data) of the learning of the students, and evaluating and interpreting the data for the improvement and development of the students' learning process [16].

Setting of the Study

This study was conducted and designed specifically for the College of Engineering at the Lyceum of the Philippines University-Batangas with Level 2 Program Accreditation Status for BS Computer Engineering (BSCpE), BS Industrial Engineering (BSIE) and BS Mechanical Engineering (BSME). However, this study concentrates only in BSME program. Various quality assurance mechanisms of the University require the degree programs especially engineering to carry out the OBE practices that would be best suited for the institution.
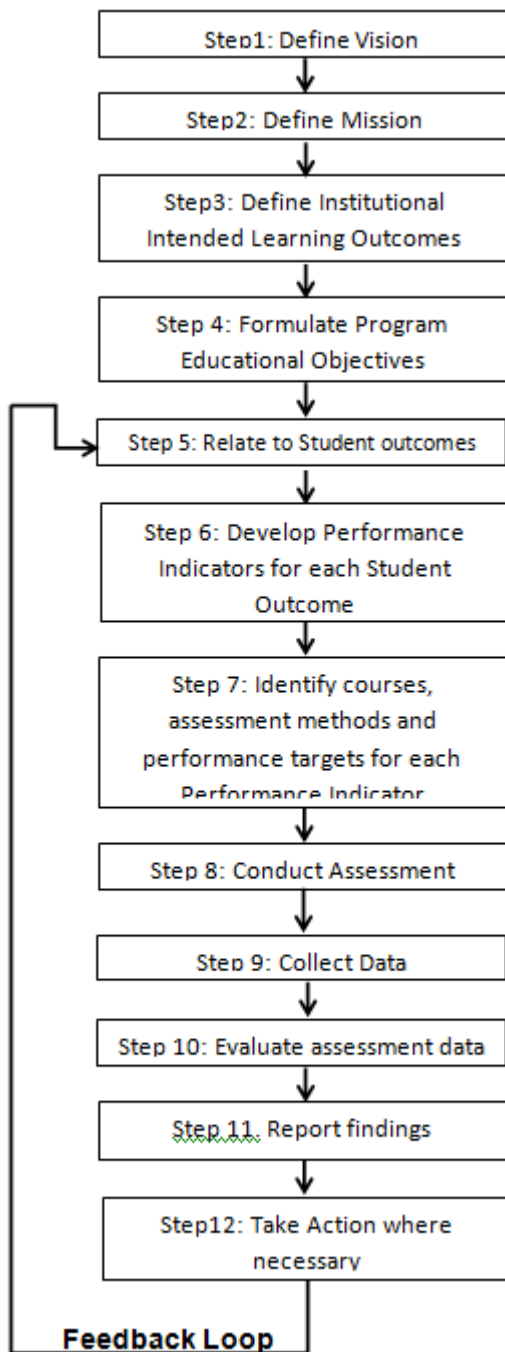
Proposed Instrument

To develop an assessment plan applicable to the University under study, this research gathered and analyzed information that could be used in the formulation of course-level assessment for the implementation of OBE.

RESULTS AND DISCUSSION

Assessment required time and effort to make it effective, but with steps to follow, like course assessment process, the tasks could be accomplished with less effort and time. As stated in the Program Assessment Handbook [15], assessment is a continuous improvement process. In order to improve, one needs to know where he is today and where he would like to go. This requires a clear articulation of the program's mission (purpose), vision (he would like to go), goals (steps to getting where he would like to be), objectives or outcomes (what you need to achieve for each step in order to get there), and measures (how well he is currently doing). Thus, in order to improve, he needs to take action."

The assessment of student outcomes process flowchart shown in figure 1 was designed following the principle of Deming cycle - Plan-Do-Check-Act. Steps 1 to 7 are the plan stage, steps 8 and 9 are the do stage, steps 10 is the check stage, and steps 11 to 12 are the act stage. Feedback loop provides mechanism to relate the result of the assessment to the attainment of student outcomes that will serve as baseline information to the improvement on the delivery of instruction and input to the student development programs.

Step1: Define Vision

Step2: Define Mission

Step3: Define Institutional Intended Learning Outcomes

Step 4: Formulate Program Educational Objectives

Step 5: Relate to Student outcomes

Step 6: Develop Performance Indicators for each Student Outcome

Step 7: Identify courses, assessment methods and performance targets for each Performance Indicator

Step 8: Conduct Assessment

Step 9: Collect Data

Step 10: Evaluate assessment data

Step 11. Report findings

Step12: Take Action where necessary

Feedback Loop

Figure 1. Assessment of Student Outcomes Process Flowchart

College of Engineering Vision

The first step in the formulation of assessment process flow is to define the program vision. Vision statement is very useful in the realization of what the program should be in the future. As stated in the vision of the College of Engineering, "The College of Engineering of the Lyceum of the Philippines University intends to be a leader in engineering education in the Asia Pacific Region which develops future Engineers who are committed to serve God and country".

The college vision is also anchored in the institutional vision that focuses on the holistic development of individuals who could contribute to the economic growth of the country and advancement of technology.

College of Engineering Mission

Defining the mission statement is the second step in the assessment process flowchart. Mission statement is essential in every organization for it serves as a guide in the attainment of the vision. Program Assessment Handbook [15] defines program mission as, "The program mission is a broad statement of what the program is, what it does, and for whom it does it".

As stated in the mission of the department, "The College of Engineering of the Lyceum of the Philippines University shall produce academically and technically competent engineers who are God-fearing, nationalistic, globally competitive individuals who can assume active leaders in the field of Engineering".

Institutional Intended Learning Outcomes (IILO)

Institutional Intended Learning Outcomes (IILO) of the students is the third step. IILO serves as guide of the teachers on what to expect from the students upon completion of the course and LPU-B stated it, "LPU has identified the institutional learning outcomes which represent the qualities that all LPU students should possess when they graduate. These outcomes are anchored on the 4C's: competence, commitment, credibility and collaboration." The complete IILO statement is shown on appendix A.

Program Educational Objectives

Program Educational Objectives (PEO) is included in the program assessment process flowchart to realize the program's constituents' needs. It also serves as a guide for the students to know what the program expects from them three to five years after graduation. The formulation of the PEO is in accordance with the requirement of ABET [17], "The program must have published program educational objectives that are consistent with the mission of the institution, the needs of the program's various constituencies, and these criteria. There must be a documented, systematically utilized, and effective process, involving program constituencies, for the periodic review of these program educational objectives that ensures they remain consistent with the institutional

mission, the program's constituents' needs, and these criteria".

Student Outcomes

The purpose of the student outcomes or program outcomes is to provide the students the necessary competencies needed on the real world scenario and provide guidelines for the teachers to determine the competencies needed in the development and growth of the students to prepare them in the attainment of the PEO, which is congruent to the instruction of ABET [17] which stated that the program must have documented student outcomes that prepare graduates to attain the program educational objectives.

The student outcomes are the minimum general criteria that need to be satisfied by all engineering programs seeking for accreditation from ABET [17]. Whereas, student outcome letter l is an additional outcome provided or added by CHED. All student outcomes are carefully deliberated by CHED and therefore should be carefully and properly assessed using appropriate performance indicators which the graduates are expected to attain and able to perform by the time of graduation.

Performance indicators

Student outcomes can be broken down into more specific competencies called performance indicators which will be developed in specified courses of the program [18].

The relationships of student outcomes to performance indicators, as shown in Table 1, were carefully developed in collaboration with the members of engineering faculty, and then consulted to the parents and engineering students. The development of performance indicators strictly followed the principle of SMART (Specific, Measurable, Realistic and Time-bound) to ensure that the student outcomes will be properly and correctly measured.

Curriculum Map

The correlation between specific mechanical engineering courses in the curriculum and the student outcomes is shown in Table 2. An analogous relationship is also shown for non-mechanical engineering courses. Careful identification of the courses in the curriculum that most directly linked to a particular outcome facilitates the evaluation of the weaknesses and strengths of the students for a particular student outcome. Identifying the courses under introductory, enabling and demonstrating courses helps the program track the development and growth of the students for each student outcome.

Course Assessment and Evaluation Matrix

Course assessment and evaluation matrix for formative (enabling)and summative (demonstrating) courses were developed to complete the requirements of step 7. Tables 3 and 4 summarize the courses that addressed the performance indicators, assessment methods, assessment tools, performance targets and performance score, date of assessment, improvements, and the date of implementation.

It is necessary that the assessment methods, assessment tools and expected performance from the students be identified to measure how well the students can utilize their learning on the real world scenario. The growth and development of the achievements of the students can be measured by conducting assessment according to their specific level from enabling courses to demonstrative courses. According to ABET [17], student performance must be evaluated. Student progress must be monitored to foster success in attaining student outcomes, thereby enabling graduates to attain program educational objectives. Students must be advised regarding curriculum and career matters.

Assessment, Collection and Evaluation

There are two methods of assessment that can be used to assess the attainment of the student outcomes: direct and indirect assessment. Direct assessment like exams quizzes, recitations, and assignments which can be considered as a strong evidence of learning is the most popular assessment used by faculty; however, not all competencies can be measured by direct assessment. Table 1 shows the assessment tips provided by Rogers (2006) for direct and indirect assessments.

Table 1. Examples of Direct and Indirect Assessment

Method	Direct	Indirect	Method	Direct	Indirect
Exit and other interviews		√	Locally Developed Exams	√	
Simulations	√		External Examiner	√	
Behavioral Observations	√		Written Surveys, Questionnaires		√
Archival Data		√	Portfolios	√	
Focus Groups		√	Oral Examinations	√	
Performance Appraisal	√		Standardized Exams	√	

To make assessment effective, results of the assessment should be collected and evaluated to determine what enhancement could be done to improve the program, and what improvement and development plan could be established to enhance further the learning of the students according to identified student outcomes. Any plan developed should be collaboratively prepared by all concerned parties from which the baseline set can be used to set the target for the next cycle of the assessment.

Steps 9 to 10 cover the requirement of ABET Criterion 4 for Continuous Improvement [17] which states that "The program must regularly use appropriate, documented processes for assessing and evaluating the extent to which the student outcomes are being attained. The results of these evaluations must be systematically utilized as input for the continuous improvement of the program. Other available information may also be used to assist in the continuous improvement of the program".

It means that there must be a continuous process for continuous improvement of the program. As the program is improving, the assessment plan, together with its contents, as given here should also undergo improvement. It should be noted that the evaluation from the results of the assessment should not be used as an evaluation for individual faculty, individual student, or individual staff.

There are two ways to assess the development of competencies of the students: the formative and the summative assessment. The purpose of formative assessment is to gather data, to monitor the progress of the students, for curriculum modification, and for improvement of instruction and learning. Whereas, the summative assessment is used to evaluate the performance of the student according to their cumulative learning experiences, achievements, and specific performance tasks at a specific point of time. Whether formative or summative assessment, to make it effective, it must have the capability to measure the attainment of the students' learning outcomes. As the Program Assessment Handbook [15] inscribed:

> "The purpose of summative program evaluation is to judge the quality and worth of a program. On the other hand, the purpose of formative program evaluation is to provide feedback to help improve and modify a program. Program assessment is intended as a formative evaluation and not a summative evaluation."

Tables 2 and 3 summarize the summative and formative courses to be assessed in a particular semester.

Table 2. Assessment Schedule of Formative Courses Addressing the Student Outcomes

			A		B					c		d			E			F			g			H		I		J			K			l		
			a1	a2	b1	b2	b3	b4	b5	c1	c2	d1	d2	d3	e1	e2	e3	f1	f2	f3	g1	g2	g3	h1	h2	i1	i2	j1	j2	j3	k1	k2	k3	l1	l2	l3
Formative Courses	1st sem				ME 4111	ME 4111	ME 4111	ME 4111	ME 4111						ME 5226	ME 5226	ME 5226				ME PS2	ME PS2	ME PS2													
	2nd sem		ME 4221	ME Elec 2						ME 4217 Lab	ME 4217 Lab															ME 4221	ME 4221	SFT Eng	SFT Eng	SFT Eng	Draw 224	ME 327	ME 327	Emgt	Emgt	Emgt
	Summer											ME PS1	ME PS1	ME PS1	ME Ethics	ME Ethics	ME Ethics				ME 5123	ME 5123														

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Table 3. Assessment Schedule of Summative Courses Addressing the Student Outcomes

Summative Courses		A		B					c		d			E			F			g			h		I		J			k			l		
		a1	a2	b1	b2	b3	b4	b5	c1	c2	d1	d2	d3	e1	e2	e3	f1	f2	f3	g1	g2	g3	h1	h2	i1	i2	i1	i2	i3	k1	k2	k3	l1	l2	l3
	1st sem	ME 5224	ME 5225 lec						ME 5225	ME elec 4	ME PS2	ME PS2	ME PS2										ME 5226	ME 5226	ME 5226	ME 5226	ME 5226	ME 5226	ME 5226	ME PS2	ME PS2	ME PS2			
	2nd sem			ME 4218	ME 4218	ME 4218	ME 4218	ME 4218						OJT	OJT	OJT	OJT	OJT	OJT	OJT	OJT	OJT													
	Summer																																ME PS1	ME PS1	ME PS1

The main purpose of step 11 is to inform decision makers, especially the faculty, for their possible contributions for the improvement of the program. Actions to be undertaken should follow the principle of SMART - specific, measurable, realistic, and time bound. Any changes to be done should be based on the results of the assessment. Monitoring the results of the changes is the key to the successful implementation of OBE and continuous monitoring of the results ensures quality.

Table 4 shows the two-year cycle assessment cycle indicating the semester, and year the summative and formative courses will be assessed for data collection.

The steps for program improvement are explained by the work of Suskie (2009), "the process of Learning assessment for academic program should include the following: identification of student learning outcomes to be achieved, providing the students the opportunities to acquire skills, concepts, attitudes and processes as required by the student learning outcome, assessing how well the students have achieved the identified student learning outcomes, and implementation of change based on the results of the assessment to improve students' academic experiences" [19].

CONCLUSION

There are 12 steps defined to follow for the assessment of student outcomes: define the college vision; define the college mission; define the Institutional intended learning outcomes; formulate program educational objectives; relate to student outcomes; develop performance indicators for each student outcome; identify courses, assessment methods and performance targets for each performance indicator; conduct assessment; collect data; evaluate assessment data; report findings; and take actions where necessary. The 12 steps were created according to the principle of Deming Cycle.

Each student outcome is provided with at least two (20 performance indicators to ensure that the student outcomes will be properly and accurately measured Formative and summative courses are identified for assessment and evaluation to monitor progress of the student, curriculum modification, improvement of instruction and learning, evaluate the performance of the student according to their cumulative learning experiences, achievements, and specific performance tasks at a specific point of time.

Course assessment and evaluation for formative and summative courses that addressed the performance indicators were developed to measure how well the students can utilize their learning on the real world scenario.

Two-year-assessment cycle was developed to ensure continuous monitoring of the results and to ensure quality.

Table 4. Two-year Assessment Cycle (2016-2018)

Student Outcomes (SOs)	AY 2016-2017 (Data collection)			AY 2017-2018 (Evaluation, improvements, and Implementation.)			AY 2018-2019 (Data collection)		
	1st sem	2nd sem	Summer	1st sem	2nd sem	Summer	1st sem	2nd sem	Summer
a)Apply knowledge of mathematics and science to solve engineering problems	S	F					S	F	
b) Design and conduct experiments, as well as to analyze and interpret data.	F	S					F	S	
c) Design a system, component, or process to meet desired needs within realistic constraints such as economic, environment, social, political, ethical, health and safety, manufacturability, and sustainability.	S	F					S	F	
d) Function on multidisciplinary teams	S		F				S		F
e) Identify, formulate, and solve engineering problems	F	S					F	S	
f) Understanding of professional and ethical responsibility	F	S					F	S	
g) Communicate effectively	F	S					F	S	
h) Understand the impact of engineering solutions in a global, economic, environmental, and societal context	S		F				S		F
i) Recognize the need for, and an ability to engage in life-long learning	S	F					S	F	
j) Know contemporary issues (economic issues, environmental issues, sustainability, manufacturability issue, ethical concern, health and safety, social impact, political impact.	S	F					S	F	
k) Use techniques, skills, and modern engineering tools necessary for mechanical engineering practice	S	F					S	F	
l) Know and understand engineering and management principles as a member and leader of a team, and to manage projects in multidisciplinary environments.		F	S					F	S

Legend: S summative subject, F formative subject

RECOMMENDATION

For effective implementation of assessment process, all concerned parties should ensure that steps 1 to 7 are already accomplished before performing steps 8 to 12. Collaborative efforts of all concerned parties ensure effective implementation of the assessment process.

As much as possible, use the same assessment plan to compare the results of the present results from the previous results, and any discrepancy from the expected results to the actual results should be carefully examined and analyzed to determine the root cause, that can be used in the formulation of action plan for the enhancement of the program and learning of the students.

Develop assessment tools and conduct outcome-based assessment. Again, when developing assessment tools like rubrics, it should strictly follow the principle of SMART –Specific, Measurable, Realistic, Time bound.

Conduct further research on how to conduct assessment, collect data, evaluate assessment data, report findings, and take action where necessary.

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